

SCIENCE NEWS INFOGRAPHICS

Teaching students to gather, interpret, and present information graphically

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Look around, and you will see lots of visual data and information. Government websites and other sources are opening more and more data to public access. Scientists use graphs to represent data in their analyses, journal articles, and press releases. Designers and scientists invent new ways of visualizing data to bring science to life. Information graphics, or *infographics*, are widely used to convey complex science and its importance to society.

To be educated consumers and citizens, students need to understand and be critical of information presented in graphical form. Researchers, accordingly, have called for fostering the *representational competence* of young people (diSessa and

Sherin 2000) and developing their *multimodal literacy* (Jewitt and Kress 2003). Graphical representations of data are also emphasized in standards and high-stakes assessments. Interpreting and creating graphical representations are part of the *Next Generation Science Standards* (NGSS Lead States 2013), and students are assessed on these skills in the Program for International Student Assessment (PISA), the ACT, and state accountability exams.

This article describes models for integrating infographics into high school science classes. The goal is to teach students graphical representation, while building their 21st-century data and information literacy.

We began in 2007, when Rob Lamb, the first author, discovered *GOOD*, a magazine that publishes infographics related to science and technology (see “On the web”). Lamb combed through the publication, trying to understand each image at a deep level and the relationships among the data. In 2009, Lamb joined a group of teachers and university education researchers (including this article’s coauthors) on a grant project called Science Literacy through Science Journalism (“SciJourn”) (Polman et al. 2010 and 2012; Saul et al. 2012). This National Science Foundation (NSF)–funded grant involved young people reading and reporting science news to broaden their science literacy. The students learned to:

- ◆ search for science information
- ◆ critically evaluate the credibility of sources and make sense of ideas from multiple sources
- ◆ understand the relevance of science to their own and others’ lives
- ◆ put cutting-edge science into context
- ◆ communicate their understandings

The initial piloting of SciJourn focused on instructors teaching students how to write news-style science articles. After the grant’s first year, Lamb realized that he could teach students, in a similar way, how to read and create science news infographics.

The leap from traditional news articles to infographics energized and motivated his students. He saw them analyzing complex graphical representations and enjoying it, then asking for more examples. This led to Collaborative Infographics for Science Literacy (CISL), another NSF project aimed at enhancing understanding of science and data through the critique and creation of infographics. We developed activity models that use infographics for visual read-aloud/think-alouds, a re-visualize activity, and student-authored projects.

Visual read-aloud/think-alouds of infographics

A read-aloud/think-aloud is a technique for modeling critical science news reading (Saul et al. 2012). Teachers read news articles aloud, occasionally pausing to explain their thoughts, modeling how to critically and scientifically read the article. This shows students how teachers perceive the world, creating closer teacher-student connections.

We adapted this technique to read infographics. Every day, as students arrived in class, the teacher projected a science infographic on an interactive whiteboard (see “On the web” for a source list of professional infographics). Then, in the read-aloud/think-aloud lessons, the teacher explained how he would read the data, interpret its meaning, and understand its implications, both intellectually and personally. He asked questions that drew students’ attention to particular aspects of the infographics and encouraged student responses. He answered student questions, making clear how he used the information and data in the infographic, and how graphical representations communicated ideas and findings.

He shared his knowledge about the infographic’s scientific content and the scientific practices that informed the sources, and at times he introduced new vocabulary. He discussed how the infographic’s author conveys or could have conveyed implications for society. If time permitted, the teacher guided students in researching the infographic’s credibility. Overall, the goal was for the teacher to model his thinking and introduce his expert knowledge to help students better understand the visualizations. He also tied the discussion to diverse curricular aims that relate to other portions of the lesson unit. He occasionally built in mini lessons on topics such as the value of multiple credible sources and the proper use of shapes and colors to represent data.

“Animals in the House” (*GOOD* and Heavy Meta 2008) is a professional infographic that Lamb has used for several years to introduce the genre. The infographic (Figure 1) visually presents data on the total number of specimens—amphibians, mammals, reptiles, and birds—in selected United States zoological parks as well as visitation numbers and zoo acreage.

The zoos are ordered top to bottom, in decreasing number of total specimens.

This allows students to create and investigate various research questions.

FIGURE 1

Students viewing the “Animals in the House” infographic.

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Does zoo acreage correspond directly to number of specimens? Clearly, no. Omaha’s zoo (most specimens) is smaller than San Diego’s (fourth-most specimens). Why does San Diego have so much more space but fewer reptiles and amphibians than other zoos? What accounts for the different numbers of visitors in various zoos?

Teachers can find other professional STEM-related infographics on *GOOD* and on other websites (see “On the web”). Lamb has used infographics from these sites on topics ranging from nanoscience, the island of floating plastic garbage in the Pacific Ocean, and pandemics to the environmental impacts of buying local produce and the educational backgrounds of Nobel Prize winners. He finds students are initially quiet when he begins read-aloud/think-alouds, but as they become more comfortable with the genre, they articulate what they see. Soon, students bring infographics to class that they want to discuss. At some point a student asks if he or she can do a read-aloud. Class discussions lead to critical evaluation about how these infographics could be improved and how the students would have treated the data differently.

Re-visualizing the data in an infographic

A strong infographic depicts multiple layers of related information and data, often densely, displaying deep interrelationships among variables and ideas. This can be seen in another lesson that contributes to students’ data literacy and graphics understanding—a re-visualization of the data.

The “Animals in the House” infographic works for this activity. Students measure a graphic element of the infographic with their computers or rulers to back-calculate the number of specimens for each zoo. Then they organize those numbers on a spreadsheet. The teacher asks students to test and discuss the advantages of different chart forms for plotting the data. Which form best communicates the information?

For example, small groups of students create various xy graphs of data—visitors versus specimens, mammals versus acreage, and so on. They post all the graphs next to the infographic. This illustrates how much data the infographic contains. It also shows ways the data can be visualized and interpreted. Students then discuss what other data could be added to the infographic to answer more questions.

For instance, Lamb's students inevitably notice the large number of St. Louis Zoo visitors, despite that zoo's relatively small number of specimens. The class discusses possible explanations, such as high local population, number of tourists, and price of admission (free). Finally, they brainstorm the data needed to explore whether those explanations are correct and how those data could be visualized.

The combination of teacher and student read-aloud/think-alouds and re-visualizing activities help prepare students for creating their own infographics.

Students creating infographics

This lesson begins with a review of classroom tools needed to produce a visually compelling representation of data. Infographics authoring requires a word processing or desktop publishing program and a program to create graphs and charts from numerical data. Examples include Microsoft Word, Publisher, PowerPoint, and Excel, available for both PC and Apple platforms. Some teachers may be able to integrate more sophisticated design programs, such as Adobe Illustrator or InDesign. Free, easy-to-use tools for creating infographics directly online are also available (see "On the web").

In the first lesson on creating infographics, students compile data from their own cell phones (number of contacts, photos, and songs) in a spreadsheet. The teacher guides them in the basic spreadsheet functions of *SUM* and *percent* to synthesize their data. They then open their word processing or publishing program and create a background using shapes they draw. They find icons to represent their variables on the web. We favor Iconsperia, which provides free and sharable graphics files (see "On the web"). Saving the icons as PNG files (allowing for scaling without pixilation), students drag the images into their layouts. Next, they roughly scale the icons to represent the value of each item and adjust the

look by adding shadows and reflections. Students add labels, group the objects, and arrange them in order from most to least. In under 45 minutes, the students have produced something that looks almost professional.

Next, students choose a topic of personal interest, and the teacher works with students to define a scientific aspect of the topic and how it can be examined numerically.

Students research their topics on the web and must learn to evaluate a website's credibility. This evaluation can be based on the author's or sponsoring organization's credentials, where the information came from, and who vetted it. Simplistic generalizations, such as "a dot-com is never reliable" or "never use Wikipedia," are discouraged. Students search the web for data using general services like "FindTheData" and specialized databases like CDC Wonder, USGS/EPA's water quality data, the U.S. Census, and the Annie E. Casey Foundation's KidsCount (see "On the web"). These searches introduce students to government websites and other sources that provide credible public data and reports. This is often a student's first experience of extracting data from a large database. To stay on track, students are required to turn in a checkpoint paper that describes their topic, sources, and how they expect to use those sources.

Students then organize and create visual representations of their data and information. They usually have to process their numerical data into an understandable form and sometimes normalize it (i.e., make the data more easily comparable, for instance by showing percentages of a population instead of raw numbers) to represent the scale or scope of a phenomenon. The goal is to convey a clear message to readers in their age group.

The deadline for the infographic's first draft is typically short, so students can receive feedback from their peers, the teacher, and perhaps an expert that the teacher finds. The teacher provides comments on a PDF of their draft, and, in



our program, so does the editor of the science newsmagazine *SciJournaler*. (Peer feedback structure is taught with a lesson on providing productive input.) We use two formats for peer feedback. In the *gallery walk*, half the students display the draft infographics on their computers while the other half rotates through, providing input. The second format is provided on the commercial website VoiceThread (requires a K–12 license) (see “On the web”). Teachers upload student graphics to VoiceThread, and students provide audio or text comments.

Based on the feedback, students refine their infographics, often through several rounds of revisions. In our program, if the infographic is deemed accurate, sufficiently informative, and appealing to an audience of their peers, it has the potential to be published in the project’s newspaper, which is distributed in print and published online (see “On the web”). These projects take approximately ten 50-minute class sessions, which the teacher schedules approximately one day per week across a two- to three-month period.

For example, one student created an infographic on tornadoes in Missouri. She deemed historical data found on a tornado website (see “On the web”) credible because the source was NOAA’s Storm Prediction Center and the National Climatic Data Center. She organized the data in a spreadsheet, compiling annual and 10-year totals by month. In her publishing program, she set up a 12-month calendar and color-coded the tornadoes in each month to represent the percentage of tornadoes for the year. She then stacked 10 years of data, allowing the reader to see trends across months, years, and a decade.

Another student depicted trends in breast cancer diagnosis and mortality at various ages and among various ethnic groups (Figure 2). In one infographic, the student combined a stacked bar chart and a pie chart created with a charting program (see “On the web”). Another student, interested in the nutritional contents of sports drinks versus their cost, combined simple bar graphs (with the same scale) within iconic representations of bottles. A more artistically inclined student combined sized icons of snakes to show how deadly they were to humans, along with her own illustrations of the effects of snake bites on humans. An icon represented the snake venom’s toxicity (LD_{50} , or median lethal dose) on laboratory mice (Figure 3, p. 30).

In CISL (see “On the web”), we are testing and refining infographic critique and creation activities, so students learn science, mathematics, and visualization in an engaging way. We believe that involving youth in data journalism both inside and outside of school provides fruitful opportunities for educating future citizens. We encourage the broader sci-

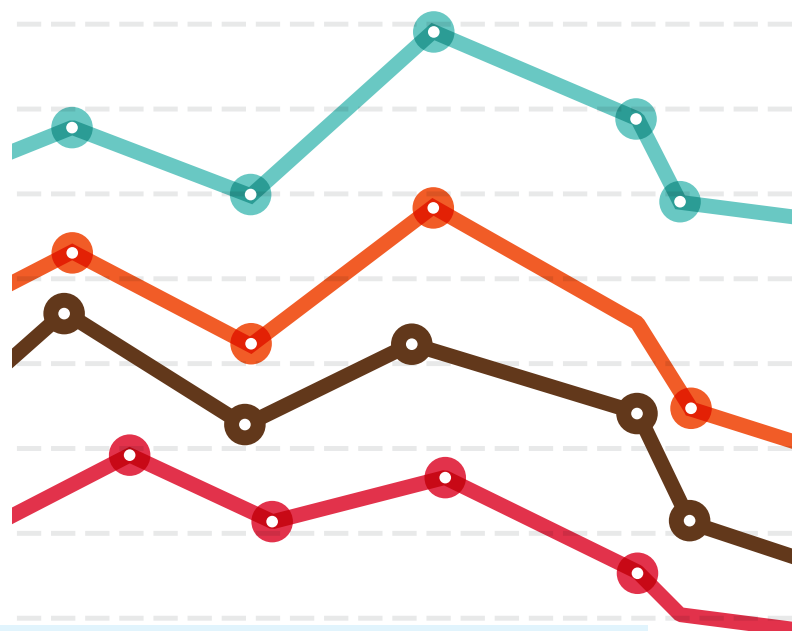
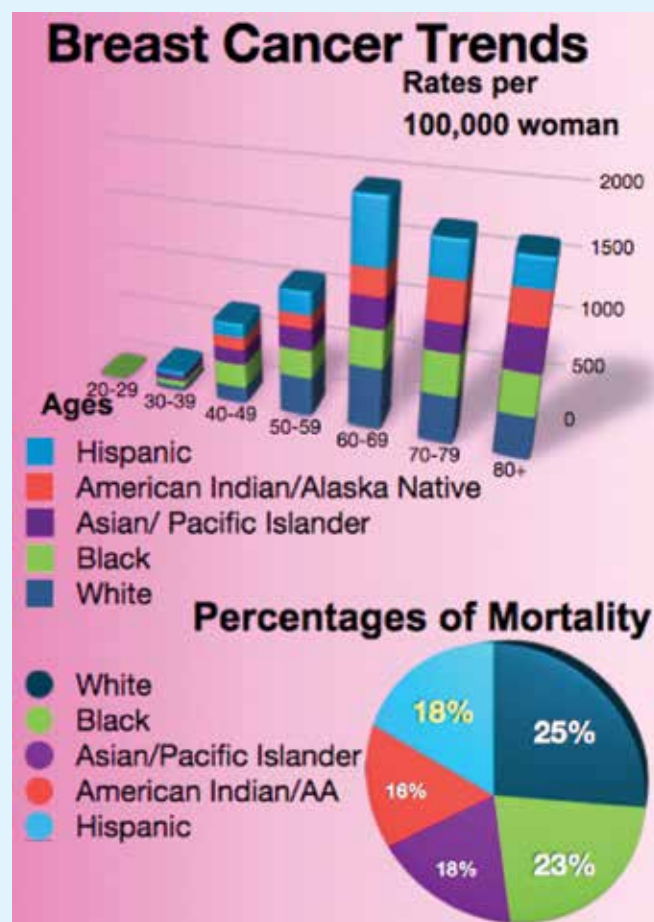


FIGURE 2

Student-created infographic on breast cancer.



ence education community to explore and refine the possible uses of infographics for science learning. ■

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On the web

Collaborative Infographics for Science Literacy (CISL):

<http://science-infographics.org>

Iconspectia: www.iconspectia.com

Science Literacy through Science Journalism (SciJourn): www.scijournal.org

SciJourn: www.scijournal.org

VoiceThread, a tool for peer feedback on infographics:

<http://voicethread.com>

Sources for professional infographics to analyze in class

Cool Infographics: www.coolinfographics.com

GOOD: www.good.is

Information is Beautiful: www.informationisbeautiful.net

The New York Times Learning Network blog on infographics:

<http://nyti.ms/1e73vhX>

Visual.ly: <http://visual.ly>

Tools for creating infographics

Gapminder: www.gapminder.org

Google Public Data Explorer: www.google.com/publicdata/

Infogr.am: <http://infogr.am>

Piktochart: <http://piktochart.com>

Sources for finding, sharing, or visualizing data

Many Eyes: www-958.ibm.com/software/analytics/manyeyes/

Tableau Public (Health and Science category):

<http://bit.ly/1fYQpr>

Sources for data to be used in infographics

CDC Wonder: <http://wonder.cdc.gov>

Find the Data: www.findthedata.org/

KidsCount Data Center: <http://datacenter.kidscount.org>

Tornado History Project: www.tornadohistoryproject.com

U.S. Census Bureau: www.census.gov

USGS/EPA water quality data: www.waterqualitydata.us

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FIGURE 3

Student-created infographic on deadly snakes.

